Equipment

Air Force Digital Dental Image CD-ROM Instructions (5/08)
Duplication of Film-Based Radiographs (4/08)
Technical Support/Warranty Information (12/07)
Planmeca ProMax Unit Cooling Fan (12/07)
Cone Extensions (12/07)
Intraoral Fixed-Mounted X-ray Units/Tubeheads (12/07)
Ordering Information for CD-R Image Storage Discs (5/07)
Cone Length Recommendations (5/07)
Minimum Computer and Monitor Specifications for Digital Image Work Stations (4/07)
Purchasing New Intraoral Fixed Mounted X-Ray Units/Tubeheads (4/07)
Leaded Aprons and Leaded Apron Holders (1/07)
Synopsis of Digital Radiography (5/05)

Air Force Digital Dental Image CD-ROM Instructions (5/08)

The Air Force Dental Service Clinical Practice Guidelines require Dental Digital Radiology (DDR) equipped treatment facilities to copy all existing digital dental patient images in their MiPACS system to a CD-ROM when a patient moves (i.e., PCS), or upon request (e.g., separation, retirement). The MiPACS software has a built-in function which copies all images plus an image viewer to a CD-ROM automatically.

Generally, this image viewer opens automatically via the Windows XP "autorun" function when the CD-ROM is inserted into a Windows-based computer. However, with the implementation of the Air Force Standard Desktop Configuration (AF SDC), autorun has been disabled. Thus, users have to run the viewer manually if the computer is running any version of the AF SDC.

While this manual running of the viewer seems intuitive to some users, others have had difficulty, even with the assistance of some of our Medical Group IT departments. Therefore, upon the recommendation and authority of the Chief, Dental Support Division (SG3DS), AFMOA, the following procedure is to be implemented immediately at all DDR enabled AF dental facilities:

1. Only CD-ROMS that conform to the pre-labeled AF Digital Imaging CD-ROM are approved for use. This CD-ROM design conforms to all IT, HIPAA and Privacy Act requirements. Information on how to order pre-printed DDRS CD-ROMs and an image of the pre-labeled approved CD-ROM has been presented previously on the DECS DDRS Web site.

2. The following information must be included on the CD-ROM envelope:

"If the radiographs on this CD-ROM do not auto load after inserting it into your computer, perform the following actions:
- Open "My Computer" then open your CD-ROM drive. Double click on the MDentView Icon.
- In a few moments the MDentView program will load. Click the "Open" button and you will be able to view and perform basic image manipulation on the images."

This Word document can be used to print Avery 5161 labels to attach to the CD-ROM envelopes. Alternatively you can create a stamp or even have the envelopes pre-printed, but this text must be included on every AF Digital Dental images CD-ROM, effective immediately.

The global server is currently going through performance and security tests. It is anticipated that within 90+ days it will be fully functional. Once this global server is fully functional and secure, it will greatly reduce or nearly eliminate our need to use CD-ROMS as digital dental image transfer media.

Return toTop

Duplication of Film-Based Radiographs: Moving from Darkrooms to Digital Scanners (4/08)

Air Force clinics that have already deployed digital radiography within the Dental Digital Radiology Solution (DDRS) or will be converting in the near future will need to purchase a flatbed scanner for the duplication of film-based radiographs. It is recommended that clinics purchase a scanner with a full page transparency adapter for film duplication.
Upon request, clinics are usually required by most states to provide copies of radiographs to patients. The conversion to digital radiography within our Air Force facilities ultimately results in the elimination of darkrooms and film processors, and the capability to efficiently duplicate existing film-based radiographs in the traditional manner.

A scanner with a full page transparency adaptor will allow the entire range of required duplication from individual periapical films, sets of BWXRs or FMXRs to panoramic and cephalometric radiographs. Since our MiPACS imaging software has the capability to link with any TWAIN* enabled scanning device, the films can be directly scanned into MiPACS. All the patient's radiographic images, scanned and digitally stored can then be copied onto a CDROM and given to the patient. A MiPACS viewer will automatically download to the CDROM which will then automatically run and display the images on any computer. This should fulfill any possible legal requirement to provide radiographs and be much less expensive than attempting to digitally print copies of the radiographs for patients.

The Air Force Academy has purchased a scanner that is functioning well in this duplication capacity. The Epson Perfection V700 Photo Flatbed Scanner ** has an 8" x 10" transparency scan area. This scanner costs approximately $500. Although, there are undoubtedly other scanners which will provide the same function, a full page transparency adapter of equal size or larger is highly recommended to ensure the capability to easily scan panoramic and cephalometric radiographs. This Epson scanner also includes four film holders for a total of twelve frame mounts for the duplication of 35 mm slides. This may be an additional benefit for staff members desiring to incorporate 35 mm slides into digital lectures.
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* **TWAIN** is a universal standard for Windows that allows imaging devices like scanners or digital cameras to communicate with image processing software. Prior to TWAIN, image acquisition devices each came with their own proprietary software. This resulted in the need to save images to disk first, and then re-open the images in the application of choice. TWAIN enables the direct import of images into a software imaging program like MiPACS

** Link to B&H Photo
http://www.bhphotovideo.com/bnh/controller/home?O=Search&A=details&Q=&sku=426013&is=REG&addedTroughType=search

Return toTop

Technical Support/Warranty Information (12/07)

Technical support agreements/options and warranty information for hardware and software within the DDRS are explained in the Force3 "United States Air Force Digital Dental Radiography System Vendor Warranty Information."

Continued technical support options for MiPACS are covered under the MiPACS Enterprise Wide License Agreement. The USAF will have the option to renew technical support and software maintenance agreements with Force3 annually. Currently, planned funding for these sustainment packages will be provided by central Digital Dental sustainment funds.

A current table/spreadsheet is provided for those Phase 1 Air Force clinics that have already deployed the DDRS as a reference for "Equipment Warranty Expiration Dates".

Return toTop

Planmeca ProMax Unit Cooling Fan (12/07)

Many clinics have installed or are planning to install the Planmeca ProMax digital panoral unit. Several clinics which have the ProMax digital unit and have the need to take high uninterrupted numbers of radiographs have experienced temporary unit shut down due to overheating. The unit automatically shuts down to prevent extensive damage which could occur with this overheating. Planmeca states that it is difficult to predict a precise number or time interval for the frequency of radiographs that will lead to unit shut down because individual facility environmental parameters (e.g., size of room, air conditioning) vary. To correct this problem, Planmeca has engineered and upon request will install a tubehead cooling fan in Pro Max units that are expected to be used for high numbers of uninterrupted panoral images. The cost of this upgrade is $125.00. Although the fan can be retrofitted to units after delivery, this carries an extra installation fee of $1,000. Besides this increased cost, it is better for the fan to be pre-installed at the factory because this installation also requires onsite recalibration of the unit which will result in clinic downtime. In the future, due to the low cost of the cooling fan, all ProMax units sold to the Air Force may have this option automatically added. Currently, clinics must specifically request this option.

Return toTop

Cone Extensions (12/07)

Many clinics have purchased new tubeheads, but have failed to purchase cone extensions. Most intraoral tubeheads come with a recessed 8-inch cone, leaving a very short portion of the cone exposed. This can decrease the accuracy when aiming the cone for the paralleling technique and can interfere with XCP positioning devices. Clinics should use the longest cone that is practical in a given treatment setting. For most dental operatories, this means purchasing an extension to provide a total 12-inch cone length. The longer cones decrease your chances of magnification and slightly reduce the radiation exposure, especially to skin. The 12-inch cones require different program settings on the x-ray units, thus it's better to have the cones available when the units are initially installed so that optimal settings are immediately programmed and used.

Return toTop

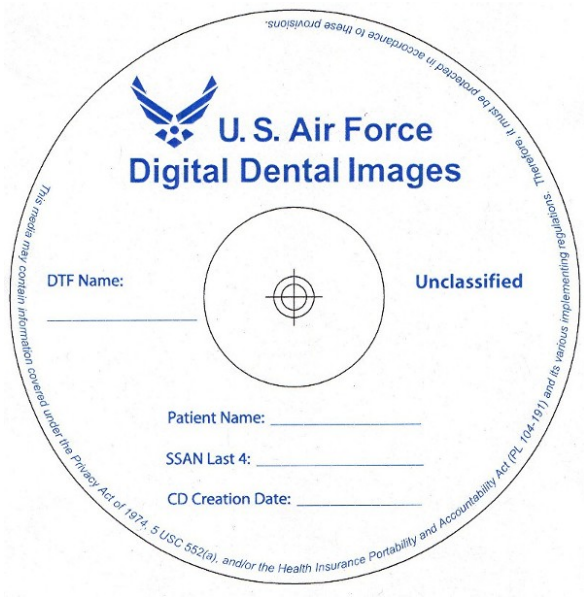
Intraoral Fixed-Mounted X-ray Units/Tubeheads (12/07)

Clinics should consider upgrading older tubeheads to the most current technology available. As the DDRS deployment progresses, it is becoming clearer that the quality of obtained intraoral digital images depends on an optimized digital radiographic system (tubehead, sensor, sensor plug-in settings, imaging software and monitor). Thus, image quality starts with the tubehead. Clinics that are using older Alternating Current (AC) units as opposed to Direct Current (DC) units may not achieve optimal results. In the same respect, clinics that are using DC units with limited exposure time settings (especially on the low end) may experience more of a challenge getting ideal diagnostic images. Purchasing New Intraoral Fixed-Mounted X-Ray Units/Tubeheads (April 2007), highlighted important considerations concerning the use of older units and considerations for the purchase of new intraoral tubeheads. Clinics which have not yet deployed the DDRS may still have time to initiate local funding packages to upgrade existing intraoral tubeheads. Most companies selling intraoral tubeheads now offer DC units with lower exposure time options (.01–3.2 sec) and adjustable mA and kVp settings. These units offer the best adaptability for current and future intraoral digital sensors.

Return toTop

Ordering Information for CD-R Image Storage Discs (5/07)

CD-R's are available from eDoc Publish Inc. with preprinted information on the disk label that includes approved Privacy Act and HIPPA statements and spaces for patient identification information. One package of 1000 CD-R's including paper sleeves with a window (# AF-DEN-Wht-CD-R-Slv) is available for $525.00 (government) plus shipping. When placing an order, USAF dental facilities are advised to contact the company representative, Mr. Thu, by calling (800) 906-0013. Additional information is listed below.

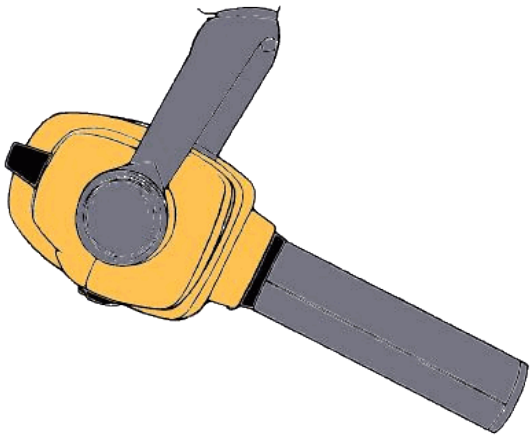


Contact Information:
eDoc Publish Inc.
14752 Sinclair Circle
Tustin, CA 92780
(800) 906-0013
(714) 368-9000 ext 307
(714) 368-9008 FAX
www.eDocPublish.com

Return toTop

Cone Length Recommendations (5/07)

If a paralleling technique is to be used, a longer cone (one at least 12 inches in length) is recommended. The National Council on Radiation Protection (*NCRP Report No.145, 2003*) states that the source-to-image receptor distance for intraoral radiography "**shall** not be less than 20 cm (8 inches) and **should** not be less than 40 cm (16 inches)." Most of our DTR intraoral units use a 12-inch cone which does not meet the "**should**" requirement in the NCRP recommendation. A 16-inch cone becomes somewhat unwieldy in a DTR. Many of our central x-ray rooms have 16-inch cones. The longer cones decrease your chances of magnification and slightly reduce the radiation exposure, especially to skin. Many 8-inch "cones" are recessed into the tubehead, leaving a very short portion of the cone exposed. This can decrease the accuracy when aiming the cone for the paralleling technique and can interfere with XCP positioning devices. **Bottom Line: If you want to follow the ALARA (As Low As Reasonably Achievable) principle and make use of optimal techniques to get the best image, clinics should use the longest cone that is practical in a given treatment setting. The use of 8-inch cones is not recommended.**



Return toTop

Minimum Computer and Monitor Specifications for Digital Image Work Stations (4/07)

Processor	Pentium 4, 2.4 GHz
Memory	512 MB
Disk space	2 GB
Network Interface	10/100/1000Mbps
Display	SXGA 1280x1024 at 24-bit color

Return toTop

Purchasing New Intraoral Fixed-Mounted X-Ray Units/Tubeheads (4/07)

In the past, many AF clinics have opted to purchase intraoral x-ray units that have limited setting options (e.g., exposure time, mA, kVp) to simplify their use and decrease the chances for errors in patient exposures. However with the introduction of digital sensors, the ability to alter these settings may be more important. The different brands of digital sensors have different sensitivities to radiation exposure. Users should be aware that what works well for film may not work well for a digital sensor, and the settings that work for one brand of digital sensor may not work for another brand.

Recently, Sheppard AFB encountered problems obtaining consistent digital images with Gendex 770 units. The Gendex 770 has a more limited timed exposure range (0.05–1.65s) than newer units, and has fixed mA and kVp settings. The relatively long minimum exposure time of 0.05 sec may be too long for some digital sensors. Overexposure may be the cause of the problem Sheppard AFB is having.

A Gendex company representative verified that the Gendex 770 is not their best unit for use with digital sensors. He stated that a possible fix is to use an aluminum filter (which Gendex can supply) that is placed behind the cone. Even with this fix, image quality will likely be compromised (contrast specifically). Software enhancements possibly can be used to compensate. If you already have Gendex 770 units or older units with fixed exposure settings and have not been using digital sensors, it may be a good idea to obtain the brand of sensor that you will be receiving in the future in the DDRS package and start to trouble shoot this potential problem now. At least one clinic reports using the Gendex 770 unit with Schick sensors and not experiencing image problems, and even some of the units at Sheppard AFB provide adequate images.

The Gendex 765DC may be a slight improvement in that it has a lower minimum exposure setting and range (0.02–2.0s), however it still has fixed mA and kVp settings. This is a direct current (DC) unit. Units using direct current, as opposed to those using alternating current (AC), may have advantages at the shorter exposure time settings used for digital radiography. DC units (sometimes called constant potential generators) produce a relatively constant stream of radiation and a greater percentage of higher energy "useful" radiation. As a result, direct current units may reduce patient radiation exposure slightly and may produce more consistent exposures at the very short exposure times used with digital radiography.

If you are going to purchase new tubeheads, a very good option is the Planmeca Intra unit. It has a lower exposure time option (.01–3.2 sec) and adjustable mA and kVp settings. It is also a DC unit. This is not the only option on the market as there are other new DC units with some of the same adjustable features; DECS will continue to explore options in this regard.

Return toTop

Leaded Aprons and Leaded Apron Holders (1/07)

Because many clinics are installing an increased number of fixed x-ray tube heads, it is important to consider the need for additional leaded aprons and leaded apron holders. Although each DTR may not individually need an apron/holder, facilities should ensure they have an adequate number of aprons and should predetermine ideal apron/holder locations so that the efficiency of radiographic procedures is not hampered.

Return toTop

Synopsis of Digital Radiography (5/05)

A synopsis table listing specifications for many currently available DIRECT digital x-ray systems can be found at the following link:
Synopsis Table: DIRECT Digital Radiography Systems

A synopsis table listing specifications for many currently available INDIRECT (photostimulable phosphor plates [PSP]) digital x-ray systems can be found at the following link:
Synopsis Table: INDIRECT Digital Radiography Systems

NOTE FOR AIR FORCE USERS: The Air Force Dental Service, through the Dental Operations Panel, has chartered an Air Force Dental Technology Board (AFDenT) to address USAF dental digital radiography issues. All dental digital radiography procurement requests must be forwarded to the clinic's MAJCOM AFDenT Board representative and approved by the AFDenT prior to being submitted for purchase. Contact your MAJCOM/SGD for your representative's name.

Digital radiography systems may be grouped into two main image acquisition categories: direct systems and indirect systems. Direct digital systems acquire images with a solid-state sensor that is connected to a computer (with a wire or wirelessly) to produce an image almost instantaneously following exposure. The other category of digital radiography, indirect digital systems, includes products utilizing photostimulable phosphor plates (PSP). Phosphor plates have a similar size and thickness to conventional film. Following intraoral placement and exposure, a phosphor plate is placed in a scanner that converts the image "stored" on the plate into a digital image. The plate is then "erased" by exposing it to a bright light prior to reusing it for further image acquisitions. There are advantages and disadvantages to both systems.

Return toTop

Direct systems

The primary advantage of direct sensor systems is the speed with which images are acquired. The sensor is connected either by a wire or wirelessly to an analog-to-digital converter box (or card), which is connected to the computer. Images are produced within seconds of sensor exposure. Most of the current sensors utilize cords (rather than wireless) and this, along with sensor thickness, may make placement more difficult than conventional film or phosphor plates. However, proper positioning techniques may minimize this disadvantage for most views. (Position the sensor further away from the teeth, more toward the center of the mouth.) Providers are reporting significant difficulty in obtaining *vertical* bitewing radiographs with corded sensors. Pediatric practices may have problems if younger children "chew" on the cord. Cost is another consideration. At several thousand dollars per sensor, sensors will likely be shared between operatories rather than purchasing one or two sensors for each operatory.

Direct sensors

System examples showing a variety of USB and Ethernet boxes and a PCMCIA card

The wire leading from a direct sensor varies in length by manufacturer, commonly being two to three meters long. This wire plugs into an analog-to-digital converter box or card. Some converter boxes connect to the computer with a USB cable. Others have an Ethernet jack for connection to a network. Some manufacturers offer both types of boxes. The analog-to-digital converter box varies in size by manufacturer. Some are small enough to secure to the arm of an x-ray unit. Others are large enough that they either sit on a counter or are wall mounted. The planned location for your converter box will affect the needed cord length on the sensor itself. The total cable length from the sensor to the computer will be the length of the sensor cable plus the length of either the USB or Ethernet cable. Some systems utilize a PCMCIA card for analog-to-digital conversion rather than a "box." This card plugs directly into the computer, so in this case the cord on the sensor itself will need to be long enough to reach from the patient to the computer. When calculating the cost of additional sensors, remember to include the cost of additional converter boxes. If sharing sensors between operatories, you can either purchase enough converter boxes to have one in every operatory or leave the sensor plugged into the converter box and share the sensor/converter box as a unit. At least one company's Ethernet box has inputs for two sensor control boxes and could potentially be shared between two operatories.

Direct digital panoramic and cephalometric units may also be purchased, or some conventional film models can be upgraded from a conventional model to a direct digital model. Once a panoramic unit has been outfitted with direct sensors it can no longer be used with conventional films (without physically converting it back to a conventional unit).

Indirect systems

As with direct systems, there are advantages and disadvantages to indirect systems. The smaller size and lack of a cord may make intraoral placement of phosphor plates easier than placement of direct sensors. Phosphor plates are somewhat flexible, but the corners cannot be bent (as is sometimes done with film) without damaging the plates. Phosphor plates can potentially be reused hundreds of times, but are susceptible to scratching which will shorten their useful life. Phosphor plates are light sensitive and exposure to ambient light must be minimized during the time period between removal from their protective cover and placement into the scanner. The length of time that plates are exposed to ambient

Phosphor plates and barriers

light during this transfer process will determine the level of allowable ambient light at the scanner location. Scanners in which plates are loaded directly into a slot can generally be used in areas of higher ambient light compared to systems in which the plates are loaded on drums prior to placement in the scanner.

Phosphor plate scanners

The primary disadvantage of phosphor plate systems involves the time required to scan and erase the plates. Following exposure, plates must be removed from their contaminated barrier pouches, run through the scanner, "erased" with bright light, and repackaged in clean barrier pouches prior to using again. For plate erasure, some scanners incorporate an "erase" cycle within the scanner itself. With other units the plates are moved to a separate plate eraser following the scanning process.

It is less expensive to purchase enough phosphor plates to place in every operatory compared to purchasing enough direct sensors for every operatory. The cost for an intraoral phosphor plate is less than twenty-five dollars compared to several thousand dollars for each direct sensor. Most existing panoramic and cephalometric units do not require expensive upgrades for use with phosphor plates. Phosphor plates are simply placed in cassettes similar to film, except that no intensifying screens are used. Therefore, the same panoramic or cephalometric unit can be used to expose either conventional film or phosphor plates. Phosphor plate systems require purchase of a scanner. Large clinics may want to purchase two or more scanners to distribute throughout the clinic.

Phosphor plate eraser

Imaging area dimensions

Size 0: 22 x 35 mm
Size 1: 24 x 40 mm
Size 2: 31 x 41 mm
Size 3: 27 x 54 mm
Size 4: 57 x 76 mm

The imaging area of direct sensors and phosphor plates listed in the synopsis tables can be compared to the imaging area of conventional dental film. Listed here are conventional film sizes for comparison purposes.

Imaging software

Prior to the development of DICOM (Digital Imaging and Communications in Medicine) standards, most manufacturers utilized proprietary image file formats that were not compatible with other manufacturers' systems. However, more and more dental imaging systems are becoming DICOM compliant. DICOM compliant systems can share image files. This makes it easier to transfer saved images from one manufacturer's system to another. While this improves the transfer of saved images, most manufacturers' imaging software still will only acquire images using that same manufacturer's sensors. In other words, with most systems, if a large clinic happened to own ten of company A's direct sensors, company B's direct pano unit, and was considering the purchase of two new sensors from company C, they could not use company A's imaging software to directly acquire images from company B's

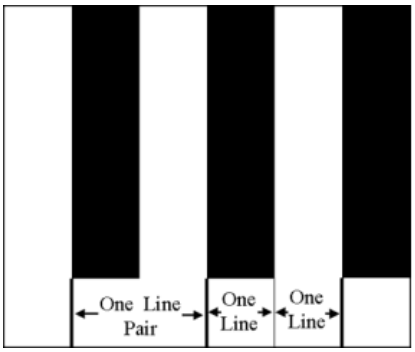
pano and company C's sensors. However, there are some "open platform" imaging software programs that can acquire digital radiography images using multiple manufacturers' image acquisition hardware (intraoral and pano/ceph direct sensors and phosphor plate systems). These programs are usually purchased separately from hardware purchases. In addition to radiography images, these programs also typically integrate digital images from other sources including intraoral and digital cameras. Using open platform software allows a clinic to choose from multiple available sensors, pano/ceph units, phosphor plate systems, and intraoral and digital cameras. Purchasing a sensor from one manufacturer would not lock the clinic into purchasing all sensors from that same manufacturer in the future. In large organizations such as the military, if all clinics utilize the same open platform imaging software, there is a consistent user interface from clinic to clinic, even though there may be some variability in the imaging hardware used. Always confirm compatibility of your desired hardware prior to purchasing open platform imaging software.

Any software installed on an Air Force networked computer must be taken through a formal certification and accreditation procedure prior to installation. This can be a lengthy process if the software has not been previously certified. Clinic personnel must coordinate software installations with information systems staff to ensure this requirement is met.

Spatial and contrast resolution

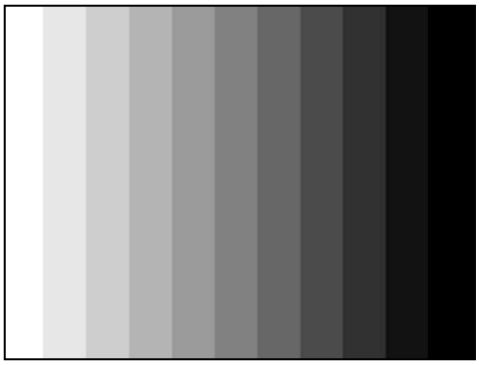
Spatial resolution and contrast resolution are two specifications often mentioned by digital product manufacturers.

Spatial resolution



Spatial resolution is generally stated in line pairs per mm (lp/mm). A line is a black or white "bar". A line pair is a set of one black and one white "bar." Resolution in line pairs per millimeter represents how many of these alternating black and white line pairs can be distinguished in a one-millimeter width. The naked eye can generally perceive between 8-10 lp/mm. Most digital sensors fall in the range of 8-15 lp/mm, which provides very satisfactory resolution for viewing dental structures. There may be a small benefit to slightly higher resolutions than this when magnification is used, but as resolution continues to increase, there comes a point where the additional resolution no longer provides more information on the object being viewed. The maximum "usable" resolution for any given object depends on the size of the object being viewed. There is an upper limit to the resolution "needed" to view dentin, enamel, alveolar bone, endodontic files, etc. Care must be taken when interpreting manufacturer resolution claims. Some manufacturers quote theoretical resolution, some quote actual (measured) resolution, and frequently there is no statement as to whether the numbers quoted are theoretical or actual values. Theoretical resolution represents the maximum theoretical resolution based on pixel size and is always greater than the actual, or measurable resolution. A pixel, or picture element, may be thought of as one of the thousands of tiny dots that make up an image. Digital sensors are composed of an array of thousands of tiny electron wells. Each of these wells typically represents one pixel in the final image. Smaller and more tightly packed wells, and thus pixels, generally result in increased resolution, but other construction factors will also affect resolution. Also, some manufacturers will use 2x2 pixel binning which effectively combines 4 small pixels (for example 19 or 20 micron) into one larger pixel (ex: 38 or 40 micron) for image production purposes.

Contrast resolution



Each pixel in an image can present as a shade of gray. Contrast resolution refers to the dynamic range, or number of grays available. This may be stated as the actual number of grays, such as 4096, or it may be stated as bit depth, such as 12 bits. Bit depth progresses in powers of 2.

1 bit 2^1 = 2 shades of gray (black and white)
2 bits 2^2 = 2x2 = 4 shades of gray
3 bits 2^3 = 2x2x2 = 8 shades of gray
8 bits 2^8 = 2x2x2x2x2x2x2x2 = 256 shades of gray
12 bits 2^{12} = 2x2x2x2x2x2x2x2x2x2x2x2 = 4096 shades of gray
16 bits 2^{16} = 2x2x2x2x2x2x2x2x2x2x2x2x2x2x2x2 = 65,536 shades of gray

Many sensors capture 12 bit images (4096 grays), some sensors capture 16 bit images (65,536 grays). Most computer monitors can only display 8 bit grayscale images (256 grays) and the human eye can typically only differentiate between 32-64 grays. If an image contains data for additional grays above what the monitor can display, the additional data may be of some benefit if the imaging software is capable of a digital processing method called windowing. Windowing is the process of selecting a certain segment of the total range of grays captured, then displaying that segment on the monitor over the full grayscale range from white to black. Windowing gives the ability to focus in on specific segments of the large number of grays captured by 12 and 16 bit sensors. While this ability may provide some advantages, current research has not supported the concept that increasingly greater bit depths improve diagnostic ability. 8 bit data provides very satisfactory images and diminishing returns are obtained from bit depths greater than this.

Infection Control Issues

The *USAF Guidelines for Infection Control in Dentistry* and the CDC's *Guidelines for Infection Control in Dental Health-Care Settings - 2003* offer similar guidance regarding the use of digital sensors. Quoting from the USAF Guidelines, sensors are categorized as semi-critical items and they:

"…should be cleaned and ideally should be heat-sterilized or high-level disinfected between patients. However, these items vary by manufacturer or type of device in their ability to be sterilized or high-level disinfected. The following apply for digital radiography sensors:

a. Use FDA-cleared barriers.

b. To minimize the potential for device-associated infections, after removing the barrier, clean and disinfect using an EPA-registered hospital disinfectant with an intermediate-level activity after each patient."

Because sensors and associated components vary by manufacturer and are expensive, manufacturers should be consulted regarding specific disinfection products and procedures. Some manufacturers recommend against using certain chemicals on their sensors. Also, some manufacturers allow immersion of their sensors while others do not.

Other considerations

Other considerations when selecting a digital radiography system include company service/support, system cost, length of warranty, and ease of use/capability of imaging software. Compatibility with open platform imaging software will be a consideration for those clinics utilizing these software packages. Adequate cable length and sensor size/shape is another consideration. Sensors with rounded edges may be more comfortable. Sensor wires exiting from the back of the sensor may make for easier placement in some situations compared to configurations where the wire exits from the end of the sensor. Sensor thickness disadvantages may be minimized when sensors are positioned properly (more toward the center of the mouth). Multiple considerations come into play when selecting a digital radiography package and there are advantages and disadvantages to all systems.

Return toTop